Face Recognition based Attendance System

Swarup Chakraborti*, Sanjukta Mishra*
Department of Computer Science and Engineering
Brainware University

***Corresponding Author**

Abstract

The attendance process is essential in any of the organization like School, College or any organization. Manual attendance process is very tedious and time consuming process. Face is one of the most individual identities that distinguish each other. Face feature of each person is different than other. This system will automatically track the attendance system of an employee. Proposed system will change the manual system and convert it to digitized system. Face recognition is one of the most popular and efficient application in image processing and also used in digital camera and mobile phone also. In this proposed system YOLO V3 algorithm is used for face detection. The main part of this system is a camera installed in front of a entry point of a door. Through this camera, face of the employee is captured first and then compares with previously stored face database and check the feature and identity of the face. When the face is identified employee's attendance will be taken automatically and necessary information will be recorded in the CSV file. If an employee is newer in an organization, his / her ID, Name will be inserted into the system first and then his face image is collected from camera and stored in the face database. Face feature is extracted through binary classifier of Convolution Neural Network. This binary classifier will check if he/she is wearing a eye glass or not or he/she has any spot in face or not or his / her face has any deformities or not.

Keyword : Face Detection, Computer Vision, Attendance System, TensorFlow, Kera

Introduction

All organization maintains an attendance [1] system of his employees. It is an essential task to find out the employee's individual performance, regularity for the entire month as well as year.

Draw Back of Manual Attendance System

In a manual attendance system there are many problem arises.

- It is time consuming process
- More man power is required
- Attendance book may be stolen
- There is a chance of forge and erroneous

Scope of this System

This smart attendance system can recognize the identity of each individual and record the face in a face database. The scope of the project is

- Staff of an organization are the target group of this system. The facial recognition process can only be done for one person at a time.
- Staff ID, Name are stored in a CSV file and attendance is also recorded in CSV file in daily basic with filename of current date. Automatic face recognition is also used in various devices like mobile phone etc. This face detection technique can also be used to find out the criminal from the CCTV footage and compare with criminal database.
- Face recognition is a task of identify a face which predefined by the system. The entire processing concepts involves under the Digital Image Processing and Computer Vision concept.

Introduction of Face Recognition and Attendance System

Face Recognition process has two parts. 1) Face Detection and Feature extraction 2) Face Recognition from Dataset. For detecting a face Viola [5] V3 algorithm is used to detect the face

from the live stream or images. Feature of the face is extracted with the help of Local Binary Pattern Histograms (LBPH) and stored. Face Reorganization processing also identifies the Spectacle on an eye and also identify if the face format is normal or abnormal. To find the Spectacle on an eye I have used Convolution Neural Network (CNN). The Convolution Neural Network uses Binary classifier returns 0 or 1 value according to the feature of Training and Testing Dataset. Face formation is also identified by Convolution Neural Network (CNN). Name and ID of an employee is entered in the system at the first time when a face is recognized by the system. Above statement is shown in the Figure 1.1 .
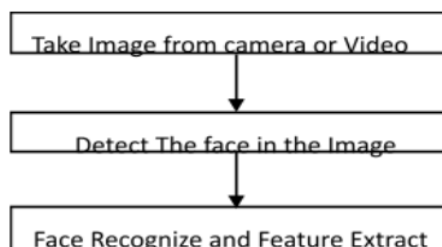
Take Image from camera or Video

↓

Detect The face in the Image

↓

Face Recognize and Feature Extract

Figure 1 .1: Operating process of face reorganization

Attendance of an employee of an organization is automatically recorded in a CSV file, if his/her face is already recognized by the system, his/her Name and ID will be shown with his/her face image. Every day a new CSV file will be generated by the system and current date will be the file name of the CSV file. CSV file will contain the Name of the Employee and his /her ID and also insert the status Present / Absent. This proposed system is less costly that other systems and also efficient.

Digital Image Processing Concept

An array of sensors are used to acquire the image in a digital form. So Digital image [10] can be represented as a two dimensional space through a function fx(x,y), where x and y are the coordinate of the image. In a digital image processing image is also represented as a matrix form which is given in the Figure 1.2. So a gray scale image can be represented in 2D space.

$$fx(x,y)= \begin{bmatrix} fx(0,0) & fx(0,1) & fx(0,2) & fx(0,N-1) \\ fx(1,0) & fx(1,1) & fx(1,2) & fx(1,N-1) \\ fx(2,0) & fx(2,1) & fx(2,2) & fx(2,N-1) \\ fx(3,0) & fx(3,1) & fx(3,2) & fx(3,N-1) \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ fx(M-1,0) & fx(M-1,1) & fx(M-1,2) & fx(M-1,N-1) \end{bmatrix}$$

Figure 1.2 : Matrix format of an image

Relation between Pixel and Color

An image contains a number of picture elements, called **Pixel.** In a black and white or gray scale image, each pixel contains only one value, either 0 (absent of light) or 1 (present of light). In gray scale image, intensity range of each color is between 0 to 255. So the dimension of an image is = number of rows X number columns x color channel. For grayscale and black and white images, color channel is 0. In RGB images color channels are 3. Image resolution is also uses in bit per pixel value. The general Color image format is RGB. RGB has Red, Green, Blue color channels. Intensity range of each color is from 0 to 255. So in color image each pixel have 3 color channels and each color channel is

represented with 8 bit per channel. So total bit depth of each pixel is 3x8=24 bpp.

Literature Review

Face Recognition Technology is one of the most popular Technology in the subject of Image Processing and Computer Vision. It identifies Human Face from digital Image or from Video Frame and matches it with predefine database of faces. It identifies the face by extracting the previous face feature of same image and compares it with current face of the current image. It is basically used to authenticate the user through ID verification service. Today this technology is used in various applications. Face Recognition Base Attendance system is another important technology which identifies the face of a person of that organization and marks the attendance digitally. Face of that person is already stored in the system.

Kanade proposed the facial recognition technology[12] in 1977. In America, The Defense Advanced Research Project Agency (DARPA) and the Army Research Laboratory (ARL) established the face recognition technology in 1993, After that various research work was started on this technology. One of the most popular and efficient technology was discovered in 2001 by Paul Viola[3] and Michael Jones, a Real-time face detection technique from video footage. It basically uses the AdaBoost Technology.

Yohie Kawaguchi et.al [3] was designed a system that was used to continuous observation and using face recognition. They were developed an Realtime student detecting method. In this system two cameras were used. One camera was used for sensing camera, that was used to identify number of seats inside class and another camera was used to capture the face. The two cameras were installed in the classroom wall.

In this paper author [4] used the Viola Jones [5] algorithm for face detection. Here author have considered several parameters of face image like sharpness, brightness and resolution of image and also considered the head position, Convolution Neural Network is to map the dimensionality of the image.

N. Kar [11] has used a new approach in a Face Reorganization based automated attendance management system .Author used the Principal Component Analysis (PCA) and FLTK(Light Tool Kit) and OpenCV [9] library. Haar Cascade is used access the frontal image. In this algorithm after cropping the face image, Principal Component Analysis is applied to recognize the face with the measuring the distance.

Onur Sanli and Bahar Ilgen [7] published a paper in Springer Journal on the topic of 'Face Recognition based attendance System'. Sikandar Khan , Adeel Akram , Nighat Usman [6] (Springer Nature), another paper was published on 'Real Time Automatic Attendance System for Face Recognition'. This system used Face API and OpenCV [9]. Both of the papers have proposed a system for automatic attendance management of class students of an educational institute on the basic of facial recognition. Authors of this paper [7] uses Principal Component Analysis (PCA), LBA based system to recognize the face and used Haar cascade classifier to identify the faces from the classroom camera.

These system will access multiple faces at a time through CC Camera, which is installed in the class room and the find out the every single face from the group faces and the recognizes the faces with predefine face database and at last attendance system is recorded. For face identification purpose both of the system used Haar Cascade Classifier (Viola-Jones Algorithm) for identifying the face. Here face is captured first and then cropped the face. After cropping the face some background is removed. The cropped face is converted to grayscale image and stored in the face database. Here two files were used to store the data. One file stores the students' information of a class and another file is used to keep track of the attendance.

In this system the attendance will be recorded only for employees of an organization. Here only

single face will be recognized at a time, instead of multiple faces. This digital attendance system is very easier and less time required and also effective. If an employee is new in an organization, his/her attendance will not be recorded until his/her recognized face image is inserted into the system. First time when an employee's face is recognized, system will capture the various facial features from the image and stored it the Userdetails.csv file with user ID, Name and facial characteristic. At the time of attendance, image of the employee's face is captured and compare with stored image in the image database. If the face feature is matched with system his attendance is granted and stored in separated CSV file. Every day a new attendance file will be generated with the filename of current date.

Algorithms for image processing

In this proposed system we have used Viola-Jones Algorithm i.e CascadeClassifer, to detect the face. Local Binary Pattern Histogram (LBPH) is used to extract the feature of face for recognizing the face. Convolution Neural Network (CNN) is used to eye glass detection and also face format detection.

Algorithm of Viola-Jones

Violo-Jones algorithm is a very popular algorithm for Face detection and Haar cascade classifier, which is available in OpenCV library, is used to detect the face.This algorithm takes 20 steps of comparison to find out if the image has a face or not. AdaBoost Technology is used to remove the redundant features and extract the actual feature. The matching process is done on grayscale image. So this algorithm has four stages. The stages are

    a) Haar Feature Selection
    b) An Integral Image Creation
    c) Use of AdaBoost Technology
    d) Cascading Classifier

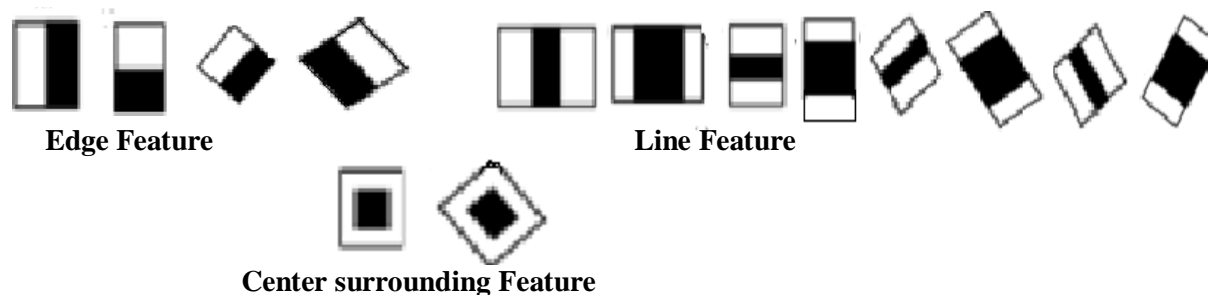Below figures 3.1 shows the Edge, line and center surround features of Haar Cascade Classifier.

Edge Feature   **Line Feature**

Center surrounding Feature
**Figure 3.1: Haar cascade edge, line ,center-surround feature extractor**

The formula of the above technology is given below

$$Q(X)= \square\ Ti * qi(X) \hspace{3cm} (1)$$

Here Q(X) is the strong classifier and Ti is the weight of each weak classifier qi(X). Through this algorithm specific objects are find out from images or video frames after scanning the similar shape.

Local Binary Pattern Histogram (LBH)

LBH is one of the simple and efficient face recognition algorithm. Ojala et al. [15] was the inventor of this algorithm. It detect the frontal faces and side face also, Pixels of the neighbor of an image is labeled using texture measurement operations with threshold values. A tag is created for each pixel with value of 1 or more 0. Labels are used to compare the adjacent pixels to the center of pixel NxN. Here LBPA,R is defined by three different circular neighborhoods. Here 'A' represents the number of neighboring pixels and 'R' represents the sampling Radius as it is shown Figure 3.2.
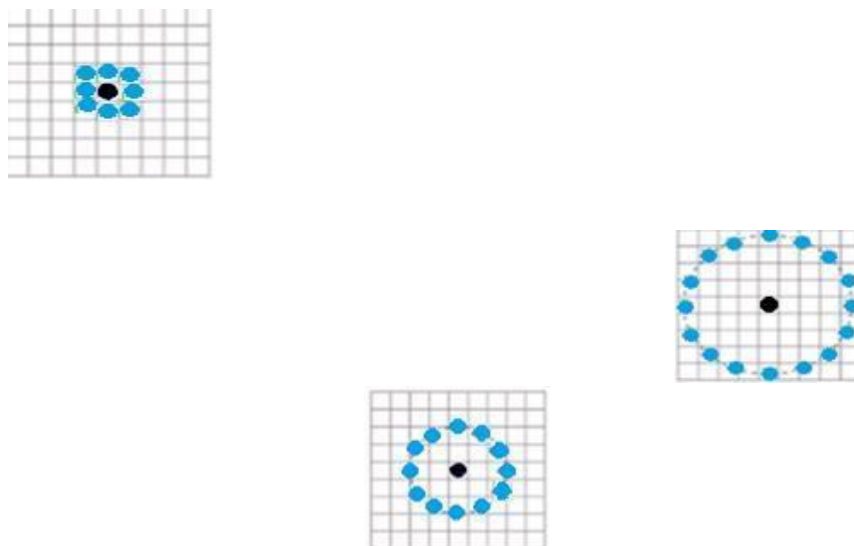
(A=8, R=1)   (A=12,R=2.5)   (A=16, R=4)
FIGURE 3.2: VARIOUS CIRCULAR LBP P,R OPERATOR

In this algorithm[24 four parameters are used.

Radius: Around the circle a local binary pattern is build up, bas on the center of a pixel, set the value 1.

Neighbors: It is the number of data points, that build up a circular local binary pattern.

Grid X : It is the number of cell in the Horizontal direction. Generally the value is 8.

Grid Y : It is the number of cell in the Vertical direction. Generally the value is 8.

The formula of LBP(A,R) with n x n matrices is given below

$$u(y) = \begin{cases} 1, y \geq 0 \\ 0, y < 0 \end{cases}$$ (2)

$$LBP_{(A,R)} = \sum_{A=0}^{A-1} u(x_A - x_c) 2^A$$ (3)

Here y is the difference between the center pixel and its neighboring pixel. Here center pixel is xc and xA is the neighbor of center pixel. Here u(y) is the bit produced by LBP operator.

Convolution Neural Network (CNN)

Like Biological neuron artificial neuron and its network has build up depending upon the biases and along with learnable weight. Convolution Neural Network (CNN) is   based on artificial neural network and entire concept is built on the basic of the algorithm of Deep Learning.. So the four important layers of Convolution Neural Network are

e) Convolution Layer- defines filters, number of input channels, additional hyperparameters
f) Activation function is used in ReLU (Rectified Linear Unit) layer
g) Pooling Layer- reduce the dimensions of data
h) Fully Connected Layer – used to connect every neuron of each layer

Result

In this System Face of an employee of an organization will be inserted into the system first with his/her Name and ID.
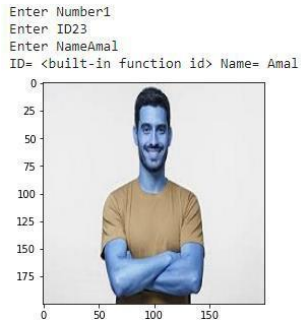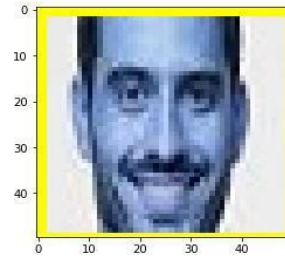

FIGURE 5.1: FACE IMAGE OF A NORMAL PERSON FIGURE 5.2: AFTER IDENTIFYING THE FACE

System will recognize the face and its feature like he/she is wearing a glass or not, his face is normal or some abnormality is shown in the face. His/her ID, Name and characteristic of face will be stored in a CSV file. Here the face is normal face no spectacles is shown. Here some of the Identified faces are shown below

The Figure 5.1 of the document shows that an image is captured first with his/her ID and Name. Then from this image face is identified and shown in Figure 5.2 and stored in the image folder. After identifying the face various face features and face type is identified by the system and stored in the CSV file. Various Feature of the face is shown below.

Figure 5.3: Various features of face

This face image shows an abnormal face image. System will capture the face of a person after entering the ID, Name of that person.
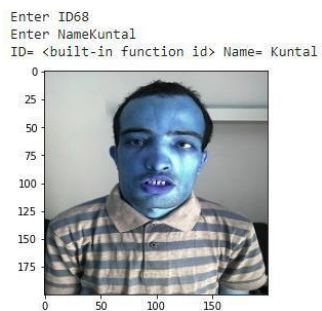

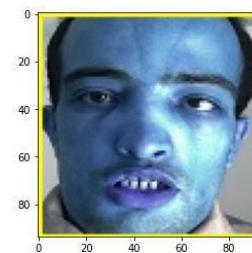**Figure 5.4: Face image of an abnormal perso face**   **figure 5.5: After identifying the abnormal**

```
No Glass
Glass value= [1.]

[[0.]]
NoSpot

[[0.]]
Irregular Face
['68', 'Kuntal', 'NoGlass', 'NoSpot', 'Irregular']
```

Figure 5.6: Various feature of identified face

After identifying the face of a person, system finds out the different features of face, which is show below.

Below Image shows that the person is wearing a Spectacle and his face has identified accurately
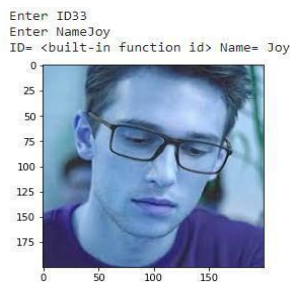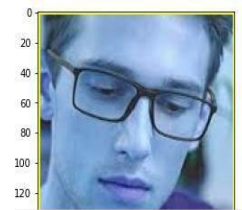

Figure 5.7: Face image, wearing spectacle   figure 5.8: After identifying the spectacle face

After identifying the face system has find out the several features of face, which is given below.

```
[[1.]]
Glass
Glass value= [1.]

[[1.]]
NoSpot
```

```
[[0.]]
Glass
Glass value= [0.]

[[0.]]
NoSpot
```

Figure 5.9: Various feature of identified face wearing spectacle

After identifying the faces and the face feature, the image of the face is stored in a folder and all the above information is stored in the Userdetails.csv file. Figure 5.11 shows the image folder and Figure 5.10, shows the content of Userdetails.csv file.
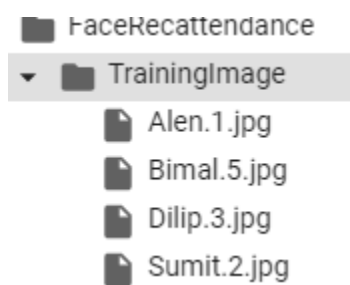
FaceRecattendance
TrainingImage
　　Alen.1.jpg
　　Bimal.5.jpg
　　Dilip.3.jpg
　　Sumit.2.jpg

UserDetails.csv ✕

1 to 5 of 5 entries Filter

Id	Name	Glass	FaceSpot	Facetype
1	Alen	NoGlass	NoSpot	Regular
2	Sumit	NoGlass	NoSpot	Regular
3	Dilip	NoGlass	NoSpot	Regular
4	Amal	NoGlass	NoSpot	Regular
5	Bimal	NoGlass	NoSpot	Irregular

Show 10 ▼ per page

Figure 5.10: Face image stored   Figure 5.11: Information of a person stored in a file

The face is recognized of the above images and identified. Attendance process of the above persons are given below. Here
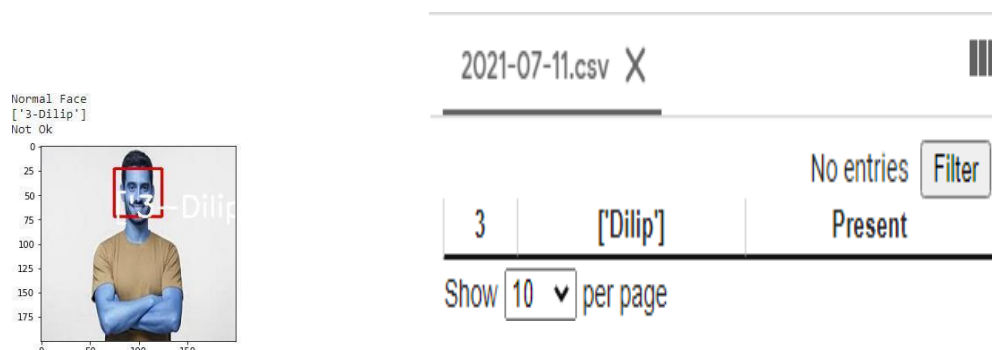

Figure 5.12 : Shows the recognized face with id and name and corresponding attendance in csv file

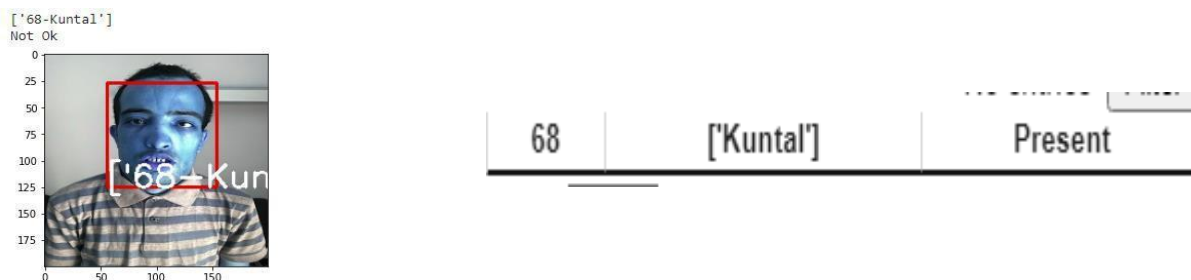Persons appear second time in the system and his face is already recognized by the system.

Figure 5.13 : Shows the recognized face with id and name and corresponding attendance in csv file

System will recognize the face and his / her ID and Name will be shown on his image and his/her attendance will be recorded.

Analysis & Discussions

System has identified the face and recognized the face on the basic of some predefined model. The model has trained properly and below figure shows the training process of the model.

```
Enter your Choice
Enter Number3
/content/drive/MyDrive/FaceRecattendance/TrainingImage/.ipynb_checkpoints
/content/drive/MyDrive/FaceRecattendance/TrainingImage/ Alen.1.jpg
/content/drive/MyDrive/FaceRecattendance/TrainingImage/ Sumit.2.jpg
/content/drive/MyDrive/FaceRecattendance/TrainingImage/ Dilip.3.jpg
/content/drive/MyDrive/FaceRecattendance/TrainingImage/ Bimal.5.jpg
Image Trained
```

Figure 5.16 : Shows the training face of the model

Here the training phase of the Convolution Neural Network (CNN) is shown below. The network used binary classifier with epoch value 20. The training process is shown with training and testing dataset. The

accuracy level is 75%. I have used 15 images for training and testing purpose. If one thousand or more images are used for training and testing purpose, accuracy level will increase.
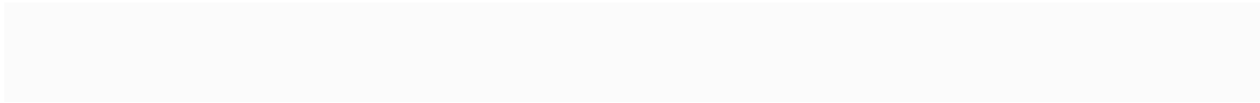
Figure 5.17: Training of a binary classifier of convolution neural network

Two graphs are shows below. The top graph shows cross-entropy loss over epochs on the basic of train
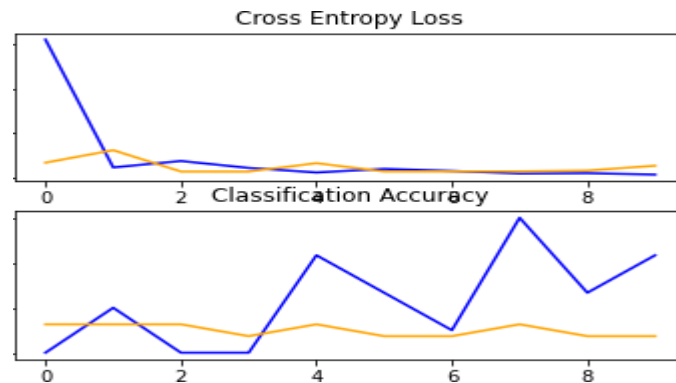

FIGURE 5.18: CONVOLUTION NEURAL NETWORK GRAPH AND ACCURACY LEVEL

(blue) and test (orange) dataset. Classification accuracy over epochs is shown in the below graph. Here accuracy rate shows 80% accurate.

Future Scope

- This system can be modified in such a way that it can track the visitor in an organization or in a school or college with the digital registration process. It can also be modified in such a way that it can be used home security purpose.
- This system can also be installed in the bank ATM. The ATM machine rooms contains CCTV camera. This camera will be equipped with face reorganization system and connected with central server of the bank and also connected with ATM machine. The customer will only access his/her account and draw money from ATM machine, if his face image is match with stored image with the bank database. It will help to prevent ATM hack, fraud and also increase the security of ATM.
- Any government organization can verify a person with recognizing his/her face with AADHAR data or organization can collect a person's AADHAR information after recognizing the face.
- Updating of the face image is also required due to the change of facial characteristics. Facial characteristic can be changed due to some disease or due to some accidental purpose. At the time of face detection face alignment, orientation and occlusion must be considered and must be implemented in the above system.
- In future with face recognition system can also use iris or retina recognition using the thermal spectrum use in the applications gives a very high degree of accuracy. In this system Local

Binary Pattern Histogram (LBPH) has used for face recognition and training purpose.

● Thermal scan of the image is also required due to COVID 19 situation. System will automatically recognize the employee's face as well as his/her body temperature at the time of attendance. If his/her temperature is not normal his/her attendance will not be granted. This type of system can also be implemented at the entry and exit point of the airport, where passenger is entering in the airport to ride the plane.

Limitations

All the system may not be hundred percent accurate and cannot be full proof system. Every system, it may be the commercial software or other system, there must have some limitation. In our system there are some limitations. Limitations of the system are given below:

● Low resolution image is not suitable for face detection purpose. It will access single image at a time. Small image size will not work properly in a face recognition system.

● In this system change of occlusion of face and orientation is not considered.

● This system runs on digital platform, so every time continuous power supply is necessary. To avoid the power cut problem a power back battery is necessary.

● Slow Computer and old Operating System and less memory and less storage location will not support this attendance system. The Operating System must be 64 bit version.

● If the database or computer is corrupted then entire system will be in vain.

● Camera will be placed in proper angel and position where face will be captured.

References

[1] S. Dev and T. Patnaik,(2020). Student Attendance System using Face Recognition,*Proceedings of 2020 International Conference on Smart Electronics and Communication (ICOSEC)* , (pp. 90-96).

[2] S. Sawhney, K. Kacker, S. Jain, S. N. Singh, and R. Garg,(2019). Real-Time Smart Attendance System using Face Recognition Techniques.*Journal of 9th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*, pp. 522-525.

[3] Kawaguchi, Yohei and Shoji, Tetsuo and Lin, Weijane and Kakusho, Koh and Minoh, Michihiko, (2005). Face recognition-based lecture attendance system.

[4] Kavinmathi, B., & Hemalatha, S. (2018). Attendance System for Face Recognition using GSM module. *In 4th International Conference on Signal Processing and Integrated Networks module.*

[5] P. Viola and M. Jones(2001). Rapid object detection using a boosted cascade of simple features. *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, (*pp. I-I).

[6] Khan, S., Akram, A. & Usman, N.(2020). Real-Time Automatic Attendance System for Face Recognition Using Face API and OpenCV. *Wireless Pers Commun*ication**.** 469–480.

[7] Onur Sanli and Bahar Ilgen (2019). Face Detection and Recognition for Automatic Attendance System. *Proceedings of SAI Intelligent Systems Conference. Springer Nature Switzerland,*237–245.

[8] M. Arsenovic, S. Sladojevic, A. Anderla and D. Stefanovic (2017) . FaceTime — Deep learning-based face recognition attendance system.*2017 IEEE 15th International Symposium on Intelligent Systems and Informatics (SISY),* 000053-000058, DOI: 10.1109/SISY.2017.8080587.

[9] Home - OpenCV. (2022, February 3). Retrieved from OpenCV website: https://opencv.org/

[10] Gonzalez, Rafael C., Woods, (n.d.). *Richard E. Digital Image Processing.* (3rd Edition). Pearson International Edition.

[11] Kar, N., Debbarma, M. K.,Saha, A. and Pal, D. R.. (2012). Study of Implementing Automated Attendance System Using Face Recognition Technique. *International Journal Computer Communication, 1(* 2),100–103.

[12]Kanade, T. (1977). *Computer recognition of human faces* (Vol. 47, p. 63). Basel: Birkhäuser.

[13] E. Varadharajan, R. Dharani, S. Jeevitha, B. Kavinmathi and S. Hemalatha (2016). Automatic attendance management system using face detection.*Online International Conference on Green Engineering and Technologies (IC-GET)*, pp. 1-3.

[14] Selvi, K.S., Chitrakala, P. and Jenitha, A.A.,(2014).Face recognition-based attendance marking system. *International Journal of Computer Science and Mobile Computing, 3*(2),337-342.

[15] T. Ojala, M. Pietikainen and T. Maenpaa,(2002).Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. *IEEE Proceedings - Transactions on Pattern Analysis and Machine Intelligence*, 24(7),971-987.

[16] Chauhan, Rajat Kumar, Vivekanand Pandey, and M. Lokanath.(2018).Smart attendance system using cnn. *International Journal of Pure and Applied Mathematics 119*, pp. 675-680.

[17]E. Varadharajan, R. Dharani, S. Jeevitha, B. Kavinmathi, and S. Hemalatha. (2016). Automatic attendance management system using face detection. *2016 Online International Conference on Green Engineering and Technologies (IC-GET)* (pp. 1-3).

[18] H. Rathod, Y. Ware, S. Sane, S. Raulo, V. Pakhare, and I. A. Rizvi,(2017).Automatic attendance system using machine learning approach.Proceeding of International Conference on Nascent Technologies in Engineering (ICNTE), pp. 1-5.

[19] Arsenovic, Marko, Srdjan Sladojevic, Andras Anderla, and Darko Stefanovic. (2017). FaceTime—Deep learning based face recognition attendance system. *Proceedings of 15th International Symposium on Intelligent Systems and Informatics (SISY),* (pp. 000053-000058).

[20] Nautiyal, Jyoti, Gahlot, Shivali, and Mishra, Pawan Kumar. (2013). An automated technique for criminal face identification using a biometric approach. *Conference on Advances in Communication and Control Systems 2013(CAC2S 2013).*

[21] M. A. Meor Said et al.,(2014).Biometric attendance. *Proceedings of International Symposium on Technology Management and Emerging Technologies* (pp. 258-263).

[22] Salton, K. (2017, November 10). Face Recognition: Understanding LBPH Algorithm - Towards Data Science. Retrieved from: https://towardsdatascience.com/face-recognition-how-lbph-works-90ec258c3d6b

[23] Bezdek J.C., Keller J., Krisnapuram R., Pal N.R. (1999) Image Processing and Computer Vision. In: *Fuzzy Models and Algorithms for Pattern Recognition and Image Processing. (* pp 547-678). Boston, MA: Springer.

[24] TensorFlow. (2021). Retrieved February 11, 2022, from TensorFlow website: https://www.tensorflow.org/